

25. On the Venous System of the Lizard *Varanus bengalensis* (Daud.). By GOBIND SINGH THAPAR, M.Sc., Professor of Zoology, Canning College, Lucknow\*.

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(Text-figures 1-4.)

The only data we possess concerning the venous system of the genus *Varanus* appear to be contained in the work of Corti, 'De Systemate Vasorum Psammosauri grisei,' 1847 (which I have not seen; the observations are reproduced in Bronn's Thierreich, vol. vi. Abt. iii. Reptilien, by C. K. Hoffmann, p. 1010); Hochstetter, "Beiträge zur Entwicklungsgeschichte des Venensystems der Amnioten, II. Reptilien (*Lacerta*, *Tropidonotus*)," Morph. Jahrb. xix. 1893, p. 464 (mainly the renal and hepatic portal systems of *V. arenarius*, according to Beddard a synonym of *V. griseus*); Beddard, "On the Venous System in certain Lizards," P. Z. S. 1905, i. p. 447 (*V. griseus*), and Beddard, "On the Vascular System of *Heloderma*, with Notes on that of the Monitors and Crocodiles," P. Z. S. 1906, ii. p. 610 (*V. griseus*, *niloticus*, and *exanthematicus*).

These descriptions, however, do not completely apply to the present species, *V. bengalensis*, common in and near Lucknow, and it seems desirable, therefore, to record the results of my investigation.

Besides ordinary dissections, injections were made through the anterior abdominal vein, using a thick solution of gum arabic to which a little colouring matter—carmine or methyl blue—was added. The fluid passes completely into the system, and it is easy then to dissect out even the finer vessels. I have used this fluid in preference to gelatine, as it can be employed cold, and sets satisfactorily after being placed for a short time in alcohol, swelling the vessels. I have to thank Prof. H. C. Ahuja, of the Central Hindu College, Benares, for supplying me with the necessary literature; and my grateful acknowledgments are due to my friend Mr. S. K. Zibbu, of the Lucknow Christian College, for the assistance he has given me in the course of my work.

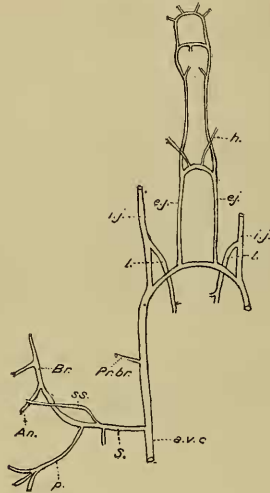
I. The System of the *Anterior Vena Cava* (text-fig. 1).

(1) The *External Jugular Vein* (*e.j.*). It is stated that this vein is ordinarily absent on the left side in Lacertilia; in the present species, however, it occurs on both sides, the vessels running parallel on each side of the trachea. It joins the internal jugular at the base of the neck. The external jugulars communicate with each other by four transverse connections, the plexuses. The first plexus is situated at the level of the thyroid gland, close to the place of union of the external with the internal

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jugular vein. The second plexus occurs a little higher up, near the hyoid, from which it receives branches (*h.*). The third and fourth plexuses are near each other, on the floor of the buccal cavity. The formation of plexuses between the external jugular veins is essentially an avian character, and I am not aware that it has hitherto been described in any Lacertilian.

Text-figure 1.



The Anterior Vena Cava and its branches.

*a.v.c.*, anterior vena cava; *an.*, antebrachial; *br.*, brachial; *e.j.*, external jugular; *h.*, hyoidean; *i.j.*, internal jugular; *l.*, lateral vein; *p.*, pectoral; *pr.br.*, prebrachial; *s.*, subclavian; *ss.*, subscapular.

(2) The *Internal Jugular Vein* (*i.j.*) receives a short vessel, the lateral vein (*l.*), from the hinder region of the neck.

(3) The *Prebrachial* (*pr.br.*) joins the vena cava at the junction of the neck with the body. It is a vessel of fair size, running along the preaxial border of the arm.

(4) The *Subclavian Vein* (*s.*) is a very large vessel running along the postaxial side of the arm; it receives many branches from the arm, shoulder, and chest, the chief of which are

- (a) Subscapular (*ss.*), from the muscles of the back,
- (b) Pectoral (*p.*), from the pectoral muscles,
- (c) Brachial (*br.*), from the arm and hand,
- (d) Antebrachial (*an.*), from the forearm.

(5) The *Azygos Vein* (text-fig. 3, *az.*), which enters the right anterior vena cava, is a fairly large vessel formed by the union of two branches, a vertebral (*v.*) from the vertebral column, and a parietal (*pa.*) from the body-wall. Beddard states that in *V. griseus* the parietal branch of the azygos is connected with

the suprarenal portal; there is, however, no such connection in *V. bengalensis*. The *lateral parietal vein* (*l.pa.*), running laterally along the body-wall, communicates with it; behind, this vein forms an anastomosis with the dorsal parieto-hepatic vein. The vertebral branch of the azygos disappears from view at the side of the vertebral column.

II. The *Posterior Vena Cava* (text-fig. 4).—This vessel begins at the hinder end of the body a little behind the kidneys, and bifurcates into two branches, each of which runs in a groove along the ventral surface of the kidney. Leaving the kidneys ("posterior cardinals," Beddard) they traverse the suprarenal bodies, beyond which they again unite. The vessel passes through the appendage of the right lobe of the liver and discharges into the sinus venosus. The anatomy thus indicates the origin of the posterior vena cava from two originally distinct vessels, the fusion of which to form a single trunk is here still incomplete.

III. The *Hepatic Portal System* (text-fig. 2) is peculiar in the present species. The *femoral vein* (*f.*) is formed by the union of several small vessels from the muscles of the leg and the pelvis; on entering the trunk it divides into two branches, the pelvic, and one which I propose to call the ischio-mesenteric. The *pelvic vein* (*p.*) runs forward along the inner border of the corpus adiposum of its side, and after receiving the sciatic (*sc.*) from the posterior region of the leg and a varying number (4-5) of veins from the fat-bodies ( $f_1-f_4$ ), unites with its fellow of the other side to form a median abdominal vein; the pelvic vein also receives two or three dorso-lumbar veins from the body-wall.

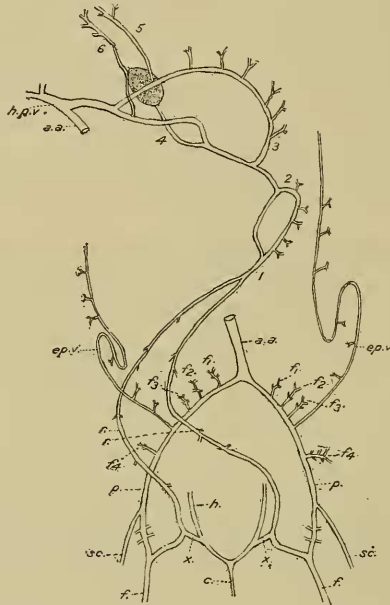
The *epigastric veins* (*ep.v.*) are two in number, and are described by Beddard as originating in *V. griseus* from the sciatic veins. In the present species I find that they arise from the pelvic; each is a fairly long narrow vessel running dorsally over the fat-body, from which it receives a few branches. It then curves backwards, and again forwards, assuming a position ventral to the fat-body, and, receiving many branches from the parietes, proceeds forwards to open into the corresponding lobe of the liver at its anterior ventral margin. Before entering the liver each is joined by a ventral parieto-hepatic vein from the ventral body-wall.

The *anterior abdominal ventral vein* (*a.a.*), formed by the union of the pelvic veins, is a single vessel throughout its course, and joins the hepatic portal vein.

The other branch of the femoral, which I have called the *ischio-mesenteric* (*r.*), is an altogether new vessel, not so far described by any observer. It receives a small offshoot (*x.*) from the hypogastric, and runs along the rectum, receiving minor branches from the rectum and cæcum. In front of the cæcum the two ischio-mesenterics unite to form one of the main roots of the hepatic portal vein.

The *hepatic portal vein* (*h.p.v.*) forms two complete loops in the mesentery of the small intestine (text-fig. 2); in the course of the second loop it receives splenic, pancreatic, and gastric veins. It runs forwards to the hinder end of the median sulcus of the liver, and after receiving the anterior abdominal vein divides into two branches, one entering each lobe of the liver towards its dorsal side.

Text-figure 2.



The Hepatic Portal Vein and its connections.

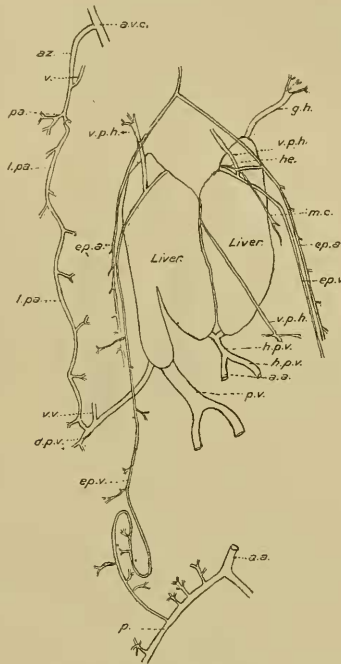
*aa.*, anterior abdominal vein; *c.*, caudal; *ep.v.*, epigastric; *f.*, femoral; *f<sub>1</sub>-f<sub>4</sub>*, veins from the fat-body; *h.*, hypogastric; *h.p.v.*, hepatic portal vein; *p.*, pelvic; *sc.*, sciatic; *r.*, ischio-mesenteric; 1, 2, 3, 4, 5, veins forming the hepatic portal; 6, gastric; *x.*, connection between hypogastric and ischio-mesenteric veins.

It would thus appear that all the blood from the limbs and alimentary canal passes through the liver before entering the posterior vena cava. A large part of the blood from the hinder region passes along the ischio-mesenteric vein into the liver, while a small part enters the kidneys by way of the hypogastric veins. Thus while the hepatic portal system is increasing in complexity the renal portal is reduced. The short connection between the hypogastric and ischio-mesenteric veins would allow the blood to flow from the ischio-mesenteric to the hypogastric or *vice versa*; but the possibility of a flow into the hypogastric is perhaps diminished by reason of the direction of the connecting vessel,

taken in conjunction with the forward stream into the hypogastric from the tail.

The *dorsal parieto-hepatic vein* (*d.p.v.*, text-fig. 3). The right lobe of the liver has a small elongated appendage on the dorsal side towards its hinder end, which encloses in its whole length the posterior vena cava. Into this appendage opens a vessel from the

Text-figure 3.



The Veins in connection with the Liver.

*d.p.v.*, dorsal parieto-hepatic vein; *ep.*, epigastric; *g.h.*, gastro-hepatic; *h.*, hepatic vein; *p.v.*, posterior vena cava; *v.p.h.*, ventral parietohepatic veins.

dorsal body-wall, the dorsal parieto-hepatic vein, supported by a pocket-shaped fold of peritoneum which, as in *Iguana* and *Heloderma*, attaches the appendage to the body-wall. This vein is described by Hochstetter, and by Beddard, who finds it in other species of *Varanus*, in the same position. The dorsal parieto-hepatic is formed by the union of the dorso-lateral vein from the body-wall with a vertebral vein from the vertebral column; the dorso-lateral forms an anastomosis with the parietal vein, as previously stated.

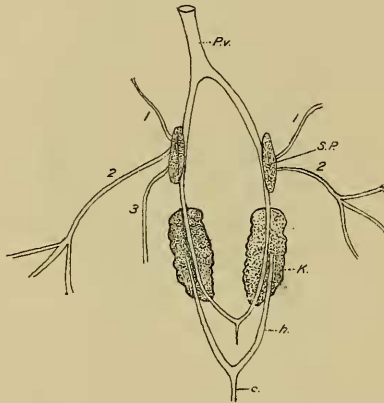
Another vessel opens into the left lobe of the liver at its extreme anterior tip—the *gastro-hepatic* (*g.h.*), coming directly

from the stomach. Hochstetter noted its position in *V. griseus*, and Beddard in *V. niloticus* and *exanthematicus*. I find exactly the same state of affairs in *V. bengalensis*.

The *ventral parieto-hepatic veins (v.p.h.)* are three in number. Two of these are laterally situated, and are connected with the corresponding epigastric vein close to its entrance into the liver. The third is a median vessel from the hinder end of the body, which receives smaller branches from the sides and enters the liver at the median sulcus near its anterior end.

IV. The *Suprarenal Veins* (text-fig. 4, 1, 2, 3).—The suprarenal bodies are situated in front of the kidneys, and each encloses the

Text-figure 4.



The Posterior Vena Cava and its connections.

*c.*, caudal vein; *h.*, hypogastric; *k.*, kidneys; *p.v.*, posterior vena cava; *s.p.*, suprarenal body; 1, 2, 3, veins forming the suprarenal portal system.

corresponding branch of the posterior vena cava. Each has its own blood-supply; the right suprarenal portal system consists of three veins: one formed by the union of three vessels of the lateral body-wall; the second, from the body-wall near the vertebral column; and the third, from the omentum. The left suprarenal portal is formed by two veins only, the vein which on the right side runs close to the vertebral column being absent.

The chief peculiarities of the venous system of *Varanus bengalensis* are thus:—

(1) The presence of jugular plexuses like those of birds, formed by the external jugulars.

(2) The azygos vein joins the right anterior vena cava, and one of its branches forms an anastomosis with the dorsal parieto-hepatic veins.

(3) Presence of an ischio-mesenteric vein, and consequent complication of the hepatic portal system.

(4) The origin of the epigastric veins from the pelvic and not from the sciatic.